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Forestry Research West

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A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

Forestry Research West

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Scientists at the Rocky Mountain Station are studying the little-known flammulated owl—a bird they believe may be a good indicator species for old-growth ponderosa pine/Douglas-fir forests in the West. Details begin on page 15

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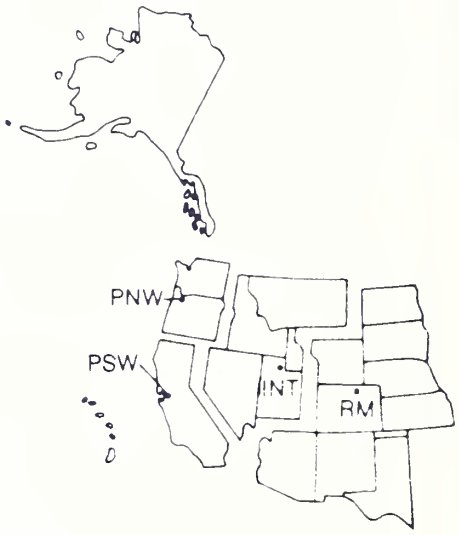


Predators and prey—a case of imbalance

by Anne Harrison
Pacific Southwest Station

Predators are usually considered to be beneficial to ungulate populations by keeping animal numbers in balance with the habitat and removing the weak and old individuals. It is also often said that: 1) predators cannot control a healthy deer population, and 2) predator numbers are controlled by the prey population size.

According to Don Neal, a research scientist with the Pacific Southwest Station's (PSW) lab in Fresno, California, a recent cooperative study by PSW and the California Department of Fish and Game has shed light on a situation where these theories appear to break down. In the study area on the west slope of the Sierra Nevada, apparently mountain lion numbers have increased while deer numbers declined to about one-eighth their peak numbers in the 1950s. Neal, along with George Steger (also with PSW), studied the California mule deer in the Sierra Nevada from 1970 to 1985 as part of an interagency effort to reverse the decline. This effort showed that the decline was primarily due to loss of fawns during the first 6-8 months of life.

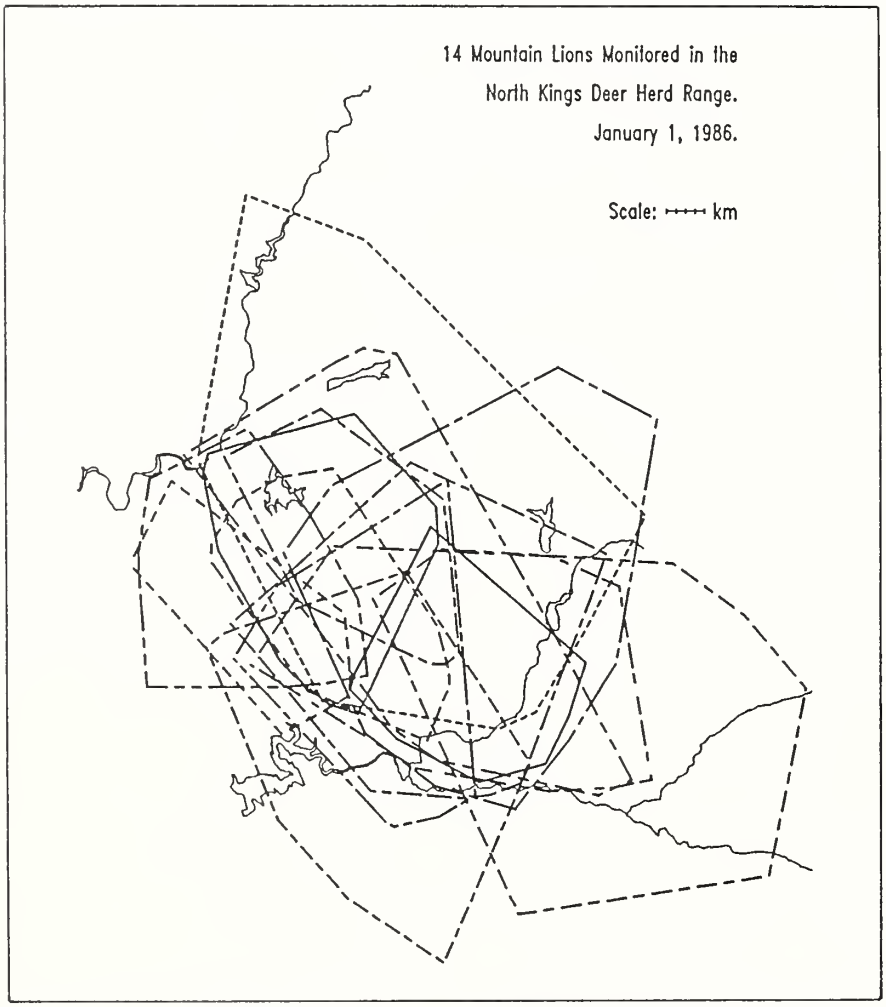
The focus of the study was the North Kings deer herd, a population of California mule deer. This herd declined from an estimated 17,000 animals in 1950 to about 2,000 animals in 1988. While the initiation of the decline was probably a result of overpopulation in the 1940s and 1950s, the lack of recovery seems to be related to heavy predation.

The size and stealth of the mountain lion makes it a very efficient predator.

Fawn survival a problem

The research team captured 96 newborn fawns and equipped them with radio collars over a 7-year period from 1979 to 1985. These radio transmitters not only allowed the researchers to determine the locations of the fawns, but they also sent out a special signal when the fawns died. This allowed researchers to locate the fawns soon after they died and determine the cause of death. They were able to monitor and determine the fate of 90 of these fawns through their first year of life.

All the fawns were healthy at time of capture, and their size and weight were comparable to those of fawns from other mule deer herds. During the 7 years of the study, fawn survival ranged from 13 percent to 42 percent and averaged 38 percent. Two percent were killed in accidents, 9 percent died from disease or birth defects, and predators were responsible for the deaths of 51 percent of the fawns. Of those taken by predators 3 percent were killed by bobcats, 22 percent by bears, 27 percent by coyotes, and 49 percent by mountain lions.



Map indicates the home ranges of the 14 mountain lions used to estimate density within the study area.

Neal and his team were at first surprised by these results, because the general perception was that mountain lions were in very low numbers in California—the State Legislature had placed them under protection in 1971. It was obvious that it would require a healthy mountain lion population to be responsible for the death of an average of 25 percent of all the fawns born each year, as was the case in the North Kings deer herd.

A look at the mountain lions

The next step was to look at the mountain lion population and gain some understanding of movements and density. They knew this would not be an easy task. So Neal and Steger asked for the cooperation of Ron Bertram of the California Department of Fish and Game.

This team uncovered some surprising results that run contrary to accepted understanding of mountain lion biology and behavior.

First, they selected a 215-square-mile area within the 800-square-mile range of the North Kings deer herd and set out to capture as many lions as time and funding allowed. Over a period of 3 years, they captured, radio equipped, and tracked 22 mountain lions. During the study they discovered 15 adult mountain lions that were using the area but were not radio-equipped, yet were known to be different individuals.

The lion locations determined by radio triangulation were computer plotted onto large-scale maps and aerial photos. This gave a good picture of daily and seasonal movements of mountain lions in the study area.

Home-range size

By plotting the locations of each cat on a map, the scientists were able to determine the size of the animal's home range and the relationships between individual lions. Home ranges of 14 adult lions tracked over 12 months averaged 285 square miles. Those of females averaged 244 and those of males averaged 340 square miles.

Seasonal movements

Each time a mountain lion was located by radio triangulation and plotted on a map or aerial photograph, the elevation was also recorded. This combination of location and elevation showed that most of the mountain lions migrated to high elevations in the summer and to lower elevations in the winter, following the patterns of the deer—their traditional prey.

However, detailed examination of the data revealed that several of the lions remained at low elevations in the foothills and valley edges throughout the year. They were found on ranches and among the rural communities. These lions occupied territories below most of the migrating deer in the winter, and these areas had no deer in the summer. This leaves only small mammals, livestock, and pets for a diet—a good way for a mountain lion to get into trouble.

Density

With the data on the radio-equipped cats, plus information on the known individuals without radios, the team had the data they needed to estimate mountain lion density.

Of the 22 lions captured and radio equipped within the 215-square-mile study area, not all were alive with operating radios during the entire study period. Therefore, one date was selected, January 1, 1987, and only the 14 lions alive and being monitored on that date were used to estimate density. This of course, underestimates the lion density because it does not include lions without radios using the area, or those with radios that have quit transmitting.

The team recognized that the number of lions using an area, and lion density are not the same thing. Every radio-equipped lion used some area outside of the 215-square-mile study area. They calculated the proportion of each animal's home range that was within the study area and used that to estimate density. In other words, if a lion's home range was 50 percent within the study area, it was counted as 0.5 cat. Therefore, the 14 adult cats using the area on January 1, 1987, adjusted to a total of 6.3 lions, or 2.9 per 100 square miles. When the scientists added in the known cats that were not radio-equipped, making a similar adjustment to allow for only partial use of the study area, they calculated the density of adult mountain lions in the study area at 6.1 per 100 square miles.

The mountain lions were examined closely before radio transmitters were attached.

Home-range overlap

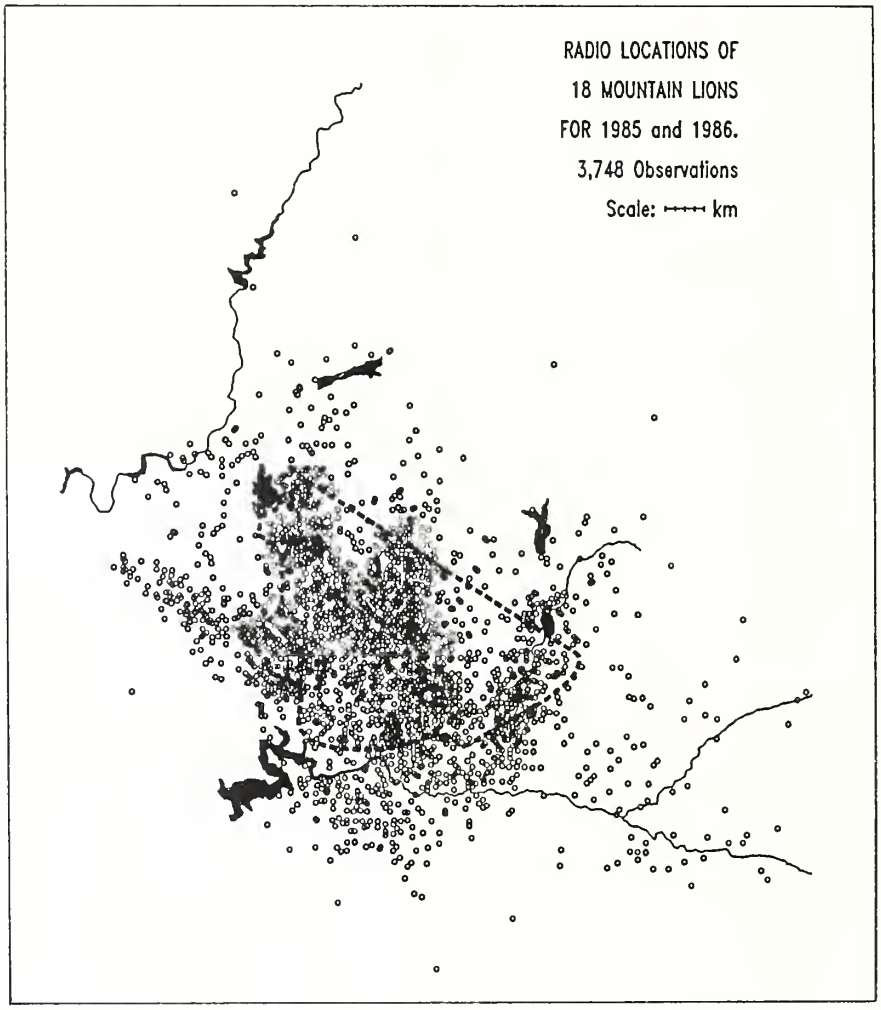
Mountain lions are generally thought to be solitary animals that defend their home ranges for their exclusive use. But, when you look at the density of mountain lions and the size of the home ranges, it's easy to see that if all the female lions maintained exclusive home ranges, there would be 7.2 times as many acres of home ranges as there are available within the study area.

This can only mean overlap and home-range sharing.

Extensive home-range overlap was found between females, between males, and between females and males. One female shared parts of her home range with five other radio-equipped females and an unknown number of males and unradioed lions.

Reproduction

Other workers have stated that when the density of mountain lions reaches the point that home ranges overlap, breeding stops. However, in this study reproduction continued at what appeared to be a normal rate; and litter size averaged about 2.5 kittens. When the known kittens are added, the density of all mountain lions using the area becomes 10.6 per 100 square miles.



Shown here is the 215-square-mile study area within the range of the North Kings deer herd, and 3,748 mountain lion radio locations obtained during two years of the study.

Adult deer are being killed also

To estimate the effect of mountain lions on adult deer, Ron Bertram and his coworkers with the California Department of Fish and Game radio equipped 25 adult does. Their work revealed that a sizable number of does were being killed by mountain lions in the central Sierra Nevada. Of 25 does radio equipped over a period of 3 years, 12 have died. One was killed by a coyote and 11 by mountain lions.

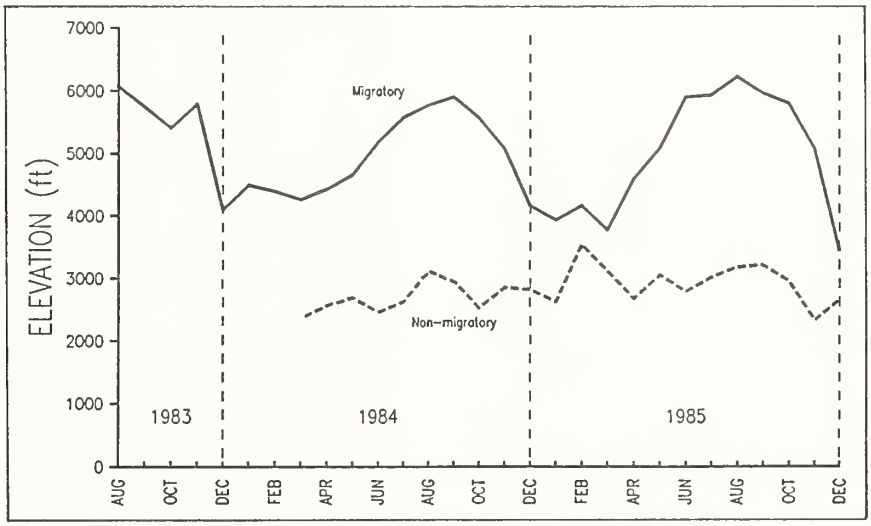
The bottom line

The bottom line is that in the study area, mountain lions appear to be controlling an already depressed deer herd, and they are apparently not benefiting the population by taking only the weak and old. The density of the lion population is not limited by the need for exclusive territories, and reproduction is continuing within this high-density population.

The magnitude of the problem can be understood when we consider that the ratio of deer to mountain lions has apparently declined from an estimated 750:1 in 1950 to about 30:1 in 1988. Deer populations cannot meet the needs of the mountain lions and maintain their numbers with the heavy predation that these ratios bring. This is especially true when you consider the additional predation from coyotes, bears, and bobcats.

Livestock losses to mountain lions have become a serious concern of this team. The number of permits to take mountain lions that are killing livestock reached an all-time high in 1988, with 145 issued and 62 lions taken. Neal, Steger, and Bertram expect livestock predation to continue at a high level or even increase, and deer to continue to decline in all but the most favorable years.

To learn more about this subject, contact the Pacific Southwest Station and request Research Note PSW-392, titled *Mountain Lions: Preliminary Findings on Home-Range Use and Density in the Central Sierra Nevada*. Several other manuscripts are in process.



Mean monthly elevations of the migratory and nonmigratory mountain lions in the North Kings deer herd range.

Reproduction has continued despite high mountain lion density in the study area.

PLANS: software for timber harvests

by Cynthia Miner
Pacific Northwest Station

Imagine for a moment you have been asked to design a harvesting system—with roads, cutting units, harvesting methods, and harvesting schedules—in a 3,000-acre watershed characterized by second growth and steep terrain with scattered unstable slopes. Your goal? A design that accounts for safety, efficiency, environmental factors, and visual impacts (a nearby trail brings hikers to an overlook directly across from a portion of the watershed). You have other considerations as well: The value of each tree is low compared with the old growth you usually harvest, and keeping harvest costs to a minimum will be particularly challenging. Skyline logging is needed in this area for all slopes greater than 15 percent, and anchors (stumps that are adequate for holding the tensioned skyline spans in place) are few and far between—coordination between harvests over time and space will, therefore, be critical for maintaining anchors.

A computer system for the job

How do you proceed? One option is the software system PLANS (preliminary logging analysis system). This new software system (available for the IBM-PC and the Hewlett-Packard 9000) helps take the guess work out of designing comprehensive area plans by providing a firm starting point for comparing alternatives and, in turn, directing field investigations and final harvest decisions.

The software system was developed at the Pacific Northwest (PNW) Research Station for resource managers (with the skills of a Forest Service GS-9 timber sale planner) to broadly plan timber harvesting in large areas of steep terrain—from positioning cutting units, landings, and roads to selecting yarding systems for timber harvest. The system allows planners to have a high level of confidence in the quality of their work. Timber-sale planners have been limited by sheer volume of work in investigating alternatives in area planning, but with PLANS they can now quickly compare several promising options in choosing alternatives that provide specific direction for field work, improve safety and efficiency, and limit soil disturbance, residual stand damage, erosion, and water quality problems.

The software system PLANS is a tool for planning timber harvests in large areas of steep terrain.

PLANS developer, Roger Twito, research engineer, demonstrates hand-tracing a contour map with a digitizing cursor—a step for creating digital terrain models when the models are unavailable from other sources.

Roger Twito, research engineer, began and has overseen the development of PLANS to provide resource managers a tool that makes large-area planning of harvests feasible. Twito sees great potential for using PLANS in conjunction with geographical information systems (GIS). The GIS provides the stored terrain information required by PLANS as well as provides space where the harvest plans produced with PLANS can be electronically stored as another data layer in the GIS. Twito has worked with a variety of users during the development of PLANS.

Some of the users of the new system

One of the first users of PLANS, as a timber sales administrator on the Willamette National Forest, Dick Connelly used the system 2 years ago to plan two timber sales of 2,000 acres each. "PLANS gets you on the road," Connelly said. "Although there is nothing like getting on the ground, PLANS can tell you if problems exist that you need to take a look at. You can easily change attributes of machinery to determine where you will use different logging methods, and PLANS helps you to see what units look like on the slope."

As second growth is quickly replacing the forests of large old trees in the West, careful area planning is becoming more important. "With old growth, you could afford more mistakes in harvesting," Peter Schiess, professor, University of Washington, explained. "With second growth, individual trees are less valuable so mistakes are more costly for what you are harvesting." For instance, smaller machines are used for second growth that have less margin for error. Machines cannot be used to overpower mistakes, as in the past, without increased risk of breakdown. PLANS can help planners examine payloads and other factors to determine what logging equipment to use where.

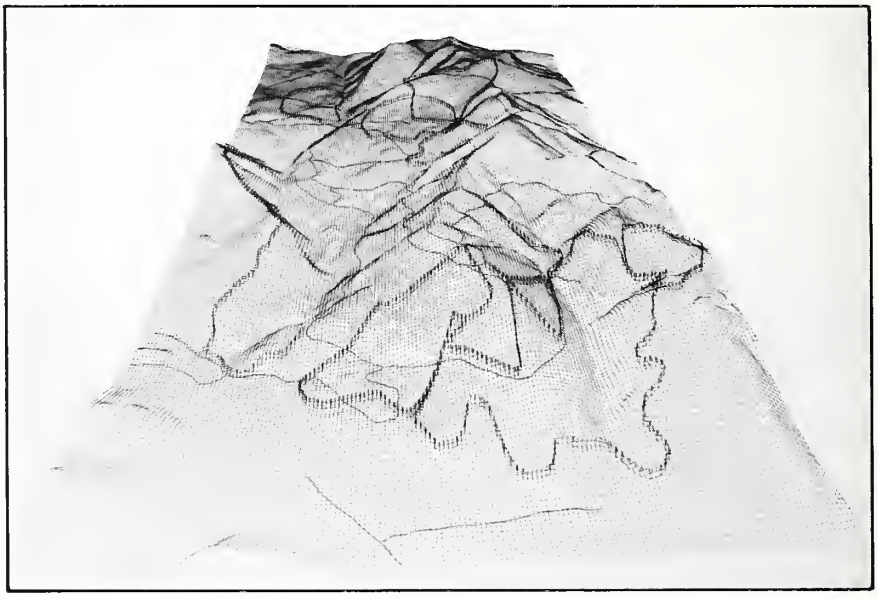
Shiess has made PLANS an integral part of an off-campus senior project in which students are actually consultants for private and public organizations. The students have been using the system as it has developed over the last 3 years. Using the completed system for the first time in spring 1988, they worked with the Washington Department of Natural Resources (DNR) in developing a 3,000-acre case study.

The Washington DNR has also used PLANS in another case study of 3,000 acres and is now developing a comprehensive planning system of which PLANS or a modified PLANS will be a component. "PLANS keeps you honest by making you work within allowable machine parameters," said Jack Cullen, harvest systems engineer, Washington DNR. "The system allows you to be more accurate in your work, and planning better resembles what will be seen on the ground."

The components of PLANS and what they do

PLANS now has eight programs. (Several other programs are in various stages of development and will be added to PLANS later.) The programs, with the exception of MAP, can be used in any order. Most output is in the form of maps. The output for the programs or for several sessions can be tied together into a single map overlay with the IBM-PC version. The Hewlett-Packard version produces maps that can be overlain by hand. With a GIS, PLANS output from the IBM-PC version can be stored and transferred to other software or hardware systems for tasks such as developing environmental impact statements.

The MAP program provides the digital terrain model (DTM) that is the foundation for planning with the seven other programs. (DTM's are data files containing ground elevations.) The DTM's can also be borrowed from a GIS, making the MAP program unnecessary. If the MAP program is used, the DTM's are produced by hand-tracing contour lines from a topographic map with a digitizing cursor—a task that goes quickly.



A display produced by the program VISUAL showing road, cutting-unit, and logging designs from other programs in the PLANS package.

The programs VISUAL and SLOPE offer two alternative visual displays of the DTM's. VISUAL produces a three-dimensional perspective that helps the planner visualize the impact of proposed activities on the landscape. SLOPE produces map-scale overlays showing areas of equal slope, aspect, or elevation. The SLOPE program helps the planner select where various logging systems may be needed, select areas suitable for winter or year-round logging, and assess planting sites.

With the program ROUTES, the planner can rapidly develop and evaluate alternatives for preliminary locations of logging roads in mountainous terrain.

The remaining four programs help analyze logging methods: SIMYARD provides estimates of the production and yarding cost of cable logging by simulating timber stand and yarder characteristics; HIGHLEAD locates and designs highlead harvest units; SKYTOWER determines skyline payloads and spans for towers from large central landings; and SKYMOBILE examines mobile yarders operating in parallel settings and permits several adjoining skylines to be designed on the same profile. These programs on the IBM-PC versions take ground profiles not only from DTM's produced by MAP but also from analytical stereoplotters, field-run profiles, and other sources.

Conclusion

PLANS provides a practical tool for area planning as it expedites efficient fitting of logging systems to the terrain and provides reliable unit designs that can be coordinated and scheduled to maximize benefits. Moreover, PLANS provides a flexible method whereby planners can approach a harvest design in a way that meets their immediate needs and allows easy repetition so that design decisions can be validated long after the design decisions are made and the harvest completed.

Although PLANS cannot be used readily by individuals without training or skills in timber-harvest planning, the system can be used as a training tool to help such individuals learn how different terrain characteristics affect yarding and other aspects of timber harvesting.

The hardware

Whether used on the IBM-PC or the Hewlett-Packard 9000, PLANS requires a plotter, digitizer, graphics screen, and printer. The user also needs topographic maps of the area—preferably at a scale of 1:4800 with 20-foot contours.

How to get the software system

Descriptions of the PLANS programs and user instructions can be obtained from the PNW Research Station, Publications, Portland (see inside front cover for address). The programs can be obtained by sending diskettes to Roger Twito. Please contact him, however, for specific information before sending him diskettes: Roger Twito, Forestry Sciences Laboratory, 4043 Roosevelt Way, NE, Seattle, WA 98105.

Yellowstone: fire prediction's greatest test

by Frances Reynolds
Intermountain Station

It was a summer unlike any in memory...unlike, in fact, any other summer in Yellowstone National Park's 117-year history. Nine major fires, some caused by people, most started by lightning, swept across almost a million acres during the summer of 1988.

Park officials' evaluation of fire danger indicators did not cause much concern in early summer. Snowpack was 80 percent of normal, and rain had fallen in April and May. Consequently, when lightning-caused fires began to occur, they were monitored but permitted to burn if they did not threaten life or property. This conformed to the policy established for the park in 1972 (human-caused fires receive immediate suppression action).

By mid-July, however, the situation was causing concern. Almost no rain had fallen since May; relative humidity was as low as 7 percent; dense stands of lodgepole pine were becoming tinder dry. Fire swept through thousands of acres, fueled by conditions that the park's policy had been designed to correct: It fed on the huge buildup of deadfall that had accumulated over decades since the last major fire. Spurred by dry winds, it spread quickly through continuous stands of overmature lodgepole, where many trees had been killed by mountain pine beetle infestation.

On July 21, with about 16,600 acres already burned, the Park Service suspended the monitoring policy; from that point all fires would be fought. To advise the Greater Yellowstone Unified Area Command in planning fire strategy, fire behavior analysts depended on fire behavior prediction methods developed at the Intermountain Research Station's Fire Sciences Laboratory (IFSL) in Missoula; the personal expertise of the laboratory's researchers was sought as well. The extreme conditions occurring during the Yellowstone fires put fire prediction methods to a severe test, and demonstrated needs for further research.

National Fire Danger Rating System

From early March, park officials had tracked the level of fire potential using the National Fire Danger Rating System (NFDRS). The system is primarily a prefire planning tool, designed to enable broad-scale assessment of weather on forest fuel conditions. Indexes and components provide information about fuel moisture of various size classes, as well as live and dead components of the forest; effect of wind and slope; and types of fuels. The information is processed, using a computer model, to produce indexes such as Probability

Crown fire making a run uphill on the Mink Fire (Bridger-Teton NF, south of the Park), about July 20, 1988.

of Ignition, Energy Release Component, and Burning Index. The Energy Release Component is designed to indicate drought conditions, and how severe fires can be expected to be as a result of lack of fuel moisture.

The NFDRS relies on data collected from fire weather stations on a daily basis. The data from each station are input and processed, using the AFFIRMS computer program, to indicate conditions at that site. While working at the Intermountain Station, Bob Burgan recently broadened the NFDRS to combine information from various sites and assess fire behavior over large geographical areas. Areas as large as half a State (or two or three smaller States) are combined to produce maps that show relative fire danger severity across the entire Country. These maps are used for large-scale fire planning by the Boise Interagency Fire Center, the National office of the Forest Service, and other units. During the fire season of 1988, they appeared frequently in *USA Today.*

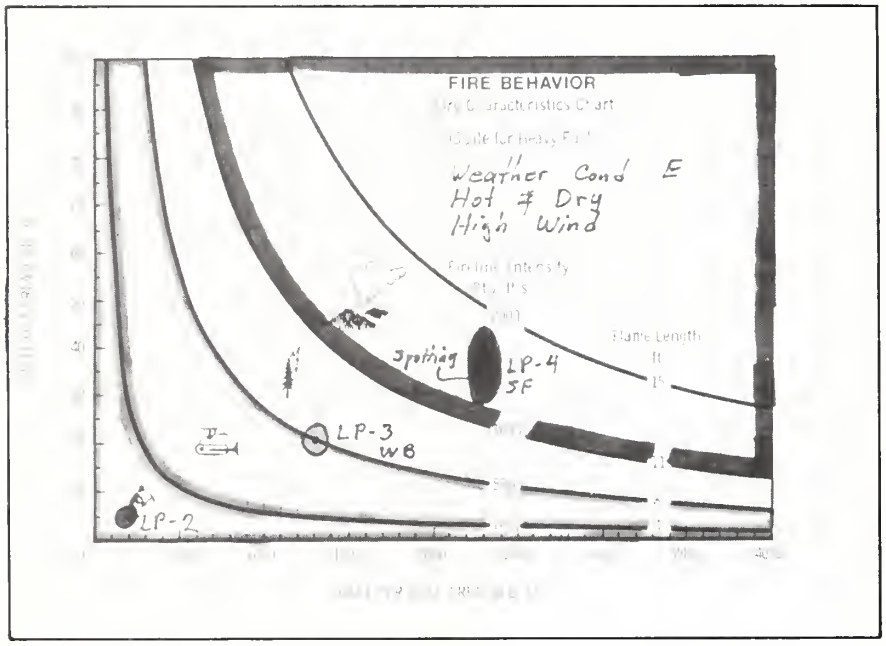
The fire command at Yellowstone also made use of the system's archival capacity. Data from previous years were compared with existing fire conditions at locations such as Mammoth Hot Springs to plan fire strategy. As fire behavior researcher Dick Rothermel (IFSL) points out, "The problem, of course, is that the National Fire Danger Rating System does not have a capability for forecasting fire conditions. It can assess how present conditions compare with the past, or work with a one-day weather forecast, but long-range fire predictions are not part of the system." During the summer of 1988, weather conditions were much hotter, drier, and windier than historical data would have suggested.

Fire Behavior Prediction System

While the NFDRS is designed for broad assessments of fire conditions, the Fire Behavior Prediction System (FBPS) is used for site-specific assessments, such as for a drainage or a section of a fire. Field data including fuels, wind, slope, and moisture are entered into the system to derive an estimate of how the fire is likely to burn. Expected fire growth in surface fuels can be displayed on a map to aid in the development of suppression strategies, and to brief fire crews on probable fire behavior.

The system provides methods for calculating fire behavior in several forms: nomograms that can be carried in the field and solved with pencil and ruler; a user-friendly computer program called BEHAVE; and preprogrammed computer chips for handheld calculators. Fire behavior analysts (FBA's) learn to use the system in rigorous classroom training supplemented by an apprenticeship in the field.

Rothermel, one of the scientists who developed the system, worked closely with FBA's at Yellowstone, and provided expert advice on unusual situations firefighters were encountering. (During the summer more than 20 FBA's rotated through fire assignments in the greater Yellowstone area.) On July 19, he worked with the incident command team at the Mink Fire. It was burning close to an area of timber blowdown that covered hundreds of acres. (The blowdown had occurred during a high-elevation cyclone the previous year.) The team conducted a 900-acre burnout in the blowdown to prevent the fire from spreading farther and endangering homes and ranches. Using the fire model developed at the IFSL, Rothermel calculated the fire's expected intensity. "We figured it generated enough energy to heat 4,000 homes in Missoula for a year," he said.



Fire characteristics chart indicating fire potential in older lodgepole pine stands in Yellowstone Park.

Advice from the experts

In late July, the command at West Yellowstone called together six fire behavior experts; they were given two and a half days to prepare estimates of how the fires in and near the park would grow by the end of the burning season. Four of the experts were from the National Park Service; Rothermel and Burgan represented the Forest Service. Rothermel recalls, "This was an extremely difficult task since there were nine major fires burning in the park at one time.

Because of the remoteness of some of the fires, it was not possible to reach them or even see the fuels from aircraft because of the smoke covering the park....It was impossible to do the close-in assessment of conditions normally done by fire behavior analysts."

Instead, to make their projections the group used Yellowstone's fuel classification system. The system maps the entire park by vegetation types related to their burning characteristics. Lodgepole pine is identified in five stages of development and decay; spruce/fir, Douglas-fir, and subalpine types are also displayed. Historical burning data from several previous years had been used to establish burning characteristics.

The group's "most probable growth" estimates for the fires were developed using a matrix between fuel types and seven classifications of possible weather, ranging from fire-stopping precipitation through a hot, dry condition with severe wind. Weather information was obtained from a climatological review of the NFDRS Fire Weather Library, and from a long-range forecast provided by the National Weather Service. For each combination of fuel and weather, they estimated probable spread rate due to surface burning, to spotting, and to crowning.

The most significant spread (up to 4 miles a day) was projected to occur in older, more decadent lodgepole pine types, on hot, dry days with strong winds. But, as Rothermel recalls, August and early September taught the experts "what 'worst case' conditions are really like." With winds of 40 to 60 mph, and relative humidity at 7 percent, the North Fork and Clover-Mist fires surprised the experts, spreading much farther than projections had indicated. "It was soon clear that the problem with the projections was that younger stages of development of lodgepole pine carried crown fires very readily," Rothermel said.

Hand drawn map showing known fire perimeter as of September 1 (left-leaning hash marks) and spread that had occurred by September 10 (right-leaning hash marks).

As the summer progressed and conditions worsened, the group assumed that spotting and crowning would occur in all lodgepole stands, regardless of age. Crown fires became so common that they could be expected every day—an unprecedented condition in modern times.

By the end of August, general fire suppression along hundreds of miles of fireline was beyond hope until the weather changed. Crown fires jumped roads and rivers and were impossible to stop. Firefighting strategy was largely limited to protecting life and developed areas, such as the Old Faithful complex and Canyon Village.

Field testing

So many strong-wind events had occurred, and fires had become so large, that a rare situation was occurring routinely: Fires were burning at night with high intensity. A research field crew from the IFSL was brought in to monitor fuel moisture. Two days and nights of testing revealed that the moisture content of fine fuels was dropping to 4 or 5 percent in the afternoon, and holding to these low values until 10 or 12 o'clock at night. Humidity recovery at night was not enough to bring these fuels above 10 or 11 percent, never reaching the "moisture of extinction" level of 15 to 20 percent, which normally slows fires at night. "Under these parched conditions," said Rothermel, "fires were able to burn around the clock." Charts were prepared to brief visiting dignitaries on effects that low fuel moisture and strong winds were having on fire behavior.

On the 6th and 7th of September, all National Fire Danger Rating indexes went into the critical range. Fires were burning throughout the West. Winds pushing the Canyon Creek Fire in western Montana reached 60 mph. On the 9th, the North Fork Fire surged north, reaching the Mammoth area during the night. The 10th was expected to produce the worst fire weather of the summer, with sustained winds of more than 40 mph and gusts up to 70 mph. Warnings went out to get crews off the firelines and into safe areas.

But on the 10th, a dramatic change in the weather finally turned the tide of the Yellowstone fires. The strong winds came as predicted, but they were accompanied by moisture. It rained in the Old Faithful area; it snowed along the north edge of the park. General humidity rose. For firefighters, the worst was over.

For Rothermel, Burgan, and other fire scientists, work has just begun. The experiences of the summer, says Rothermel, have "shown a strong need for methods of assessing extreme fire behavior.

Burnout operation in heavy down fuels on the Mink Fire (Bridger-Teton NF, south of the park), July 19, 1988.

Work in this area will be accelerated, using experience from the Yellowstone and other large fires." He identified three areas of concentration:

- Investigation of extreme fire behavior, and development of methods for predicting occurrence, intensity, and spread rates.

- Development of a fire growth model to predict fire behavior of large fires.

- Development of methods for training fire behavior analysts in prediction of extreme fire behavior.

The Yellowstone conflagration proved to be a crucible for fire prediction methods. Many predictions proved accurate, and were essential tools in planning firefighting strategy. Some failed. But the experience gained in the extraordinary summer of 1988 will lead to fuller understanding of fire behavior under the most extreme conditions.

Special forests for a special owl

by Rick Fletcher
Rocky Mountain Station

Mosses, lichens, unique wildlife and plant species, deteriorating logs, snags, clean, cold water—you're in the midst of an old-growth forest. Here, trees from a few hundred to over one thousand years old tower above all else. Old-growth forests offer special recreational opportunities and aesthetic and spiritual values. They symbolize our links to the past, and provide an important look into the natural successional processes of the forest environment.

These forests also attract the attention of the logging industry. Their timber is strong, durable, easily worked, and has high commercial value. As a result, some old-growth forests are diminishing in size.

Research by the USDA Forest Service into the value of old-growth forests has, for the most part, centered on the Douglas-fir region of the Pacific Northwest. Yet much forested area in the western U.S. is dominated by old-growth ponderosa pine. These forests play no less a major role in their regions than do the patriarchal Douglas-firs of Washington, Oregon, and northern California.

Despite their importance, not enough is known about these forests, especially the relationships between old-growth ecosystems and the wildlife species that are so dependent on them.

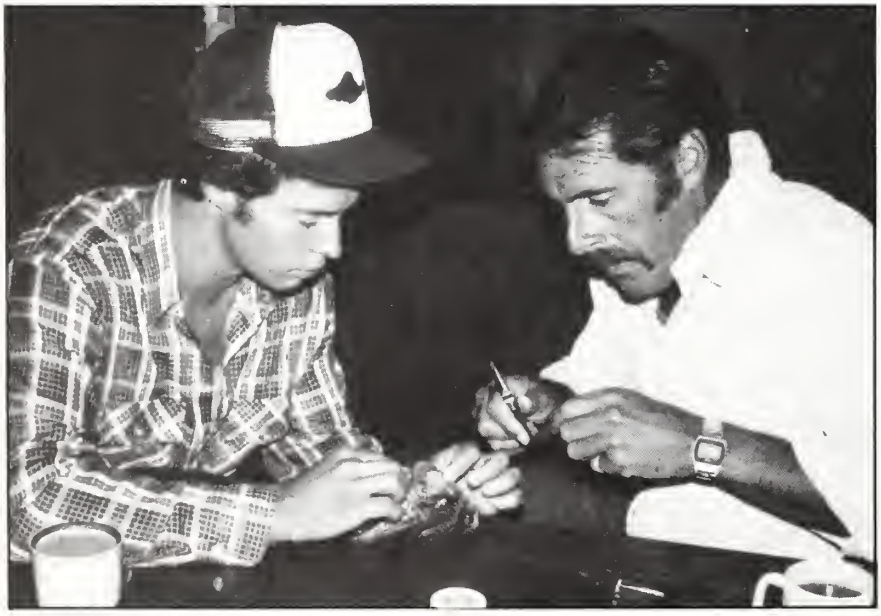
This female is feeding insects to her young.

One method being researched, and even incorporated into some forest plans, is the use of wildlife indicator species to help determine the overall "health" of old-growth forests—the rule being that as long as the species is thriving, the forest itself is in good health. Any change in population is a reflection on the forest's condition. Many indicator species have been identified for the Pacific Northwest—perhaps the most well-known being the northern spotted owl (*Strix occidentalis*). It is currently being monitored at several locations in that region.

A new indicator?

Scientists at the Rocky Mountain Station are studying what they believe may be the "northern spotted owl" of western old-growth ponderosa pine forests—the flammulated owl (*Otus flammeolus*). It is a little-known cavity-nesting, insectivorous species that is widely distributed in montane forests from the Rocky Mountains to the Pacific, and from southern British Columbia southward through the highlands of Mexico and Guatemala. The owl is one of the smallest in the West—standing only 6 inches high—is migratory, and strictly nocturnal.

Flammulated owls prefer to forage and nest almost exclusively in old-growth ponderosa pine and Douglas-fir forests.



Brian Linkhart (left), a cooperator and Colorado State University Graduate Student, and Richard Reynolds attach a backpack transmitter to a captured owl.

Research Wildlife Biologist Richard Reynolds, who spearheaded this study—the only long-term, intensive one ever done on flammulated owls—explains, "Although our research is continuing, results so far indicate that the owl prefers to forage and nest almost exclusively in old-growth ponderosa pine and Douglas-fir forests (Douglas-fir is usually mixed with old-growth ponderosa pine forests in much of the West). The owl can occasionally be found around other forest types such as aspen, blue spruce, Jeffrey pine, black oak, and western larch, but these species are usually mixed with or adjacent to ponderosa pine/ Douglas-fir stands."

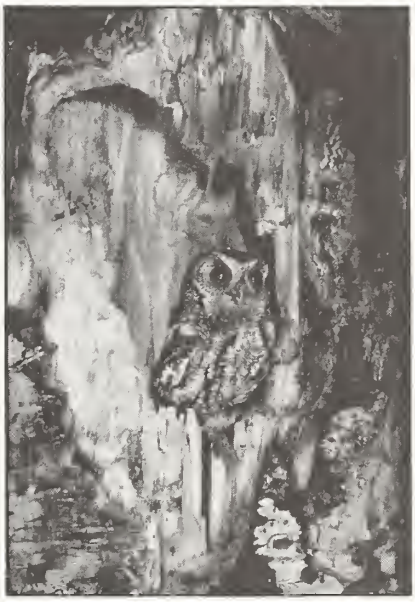
Many of Reynolds' studies took place on the Manitou Experimental Forest in central Colorado. Owls were captured after egg-laying, banded, and equipped with radio transmitters. Foraging and nesting, home ranges, individual tree use, and other behaviors were studied.

"We found that flammulated owls returning in the spring settled in stands of old-growth (greater than 200 years) ponderosa pine/ Douglas-fir," said Reynolds. "Furthermore, after settling, the owls significantly preferred to forage in old-growth pine/fir trees, and avoided younger, dense stands of other tree species."

Why old-growth?

Reynolds believes the reasons for this association involve both food and habitat structural components. "First," he said, "the owl is an obligate cavity-nester, and older forests typically have an abundance of snags and live trees with suitable cavities. Second, old pines form open stands that allow the growth of grass and shrub understories which, in turn, provide habitat for insect prey. Dropping from lower tree crowns to catch insects below is an important foraging tactic used by fledged young and adults during their late summer molt. Third, many of the abundant and cold-adapted noctuid and geometrid moths, the main food of the owls during cold spring and early summer nights, are host-plant specific, and are limited to these old-growth pine/fir forests. Fourth, the owls' three main foraging tactics, hawk-gleaning, hover-gleaning, and hawking insects, require large, open crowns and space between tree crowns. Because old-growth tree crowns are quite open, the owls can use these tactics to capture moths that are either flying or resting within the trees. The openness of the old-growth stands also provides room between trees so the owls can hover-glean insects from needle bunches on the exterior of tree crowns, and for the occasional hawking of flying moths."

Tracking foraging owls.



This female's nesting cavity has been destroyed by a bear (note the claw marks). The bear probably ate her young.

So is there enough evidence to tag the flammulated owl as an indicator species for old-growth ponderosa pine/Douglas-fir forests in the West? Reynolds believes there is. "Old-growth forests are special places," he says. "They possess unique qualities and characteristics that distinguish them from younger, less mature forests. Some plants and animals attain their highest population density and productivity in old-growth forests. Species such as the flammulated owl may disappear without sufficient acreages of old-growth ponderosa pine. If this owl can become as significant a tool for the management of western ponderosa pine forests as the northern spotted owl has become for old-growth forests in the Pacific Northwest," says Reynolds, "then I believe we'll see a much improved understanding of the ecology of western old-growth forests, and their value as an element of habitat diversity and as critical habitat for certain wildlife species."

If you would like more information, contact Richard Reynolds at the Rocky Mountain Station's Forestry Sciences Laboratory, 222 South 22nd Street, Laramie, Wyoming 82070, (307) 742-6621, FTS - 328-0300.

The following reprints are also available from the Station: *The Nesting Biology of Flammulated Owls in Colorado; Nesting Home Ranges and Habitat Use by Flammulated Owls in Colorado; Fidelity to Territory and Mate in Flammulated Owls;* and *Brood Division and Postnesting Behavior of Flammulated Owls.*

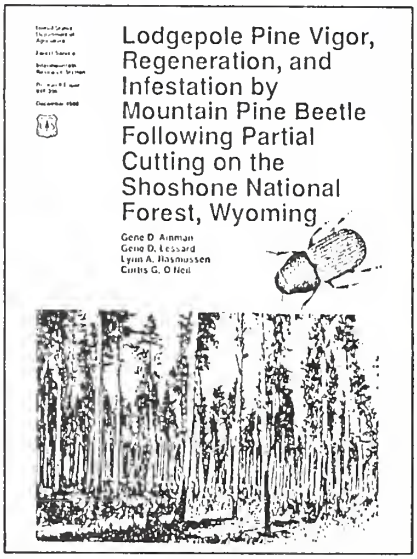
New from research

Partial cutting can reduce losses to mountain pine beetle

The mountain pine beetle (MPB) continues to kill millions of lodgepole pine annually in the western United States. Harvesting susceptible trees or modifying stand conditions that are conducive to MPB infestation are the only long-term solutions to the MPB problem.

Although clearcutting may be the preferred silvicultural option for the majority of high-risk lodgepole pine stands, concern for other resource values (wildlife cover, watersheds, view areas, etc.) limits the amount of clearcutting and frequently permits only partial treatment of susceptible stands. Managers seek options that might reduce stand susceptibility to the beetle, yet are compatible with management of other resource values.

A new publication from the Intermountain Research Station reports the results of a study to test the effectiveness of partial cutting in reducing losses to MPB. Stands were thinned in the Shoshone National Forest, using different forms of partial cutting. Average losses of trees 5 inches diameter-at-breast height and larger during the 5 years following thinning ranged from less than 1 percent in spaced thinnings to 7.4 percent in the 12-inch diameter limit cut, compared to 26.5 percent in check stands.



To learn more, request *Lodgepole Pine Vigor, Regeneration, and Infestation by Mountain Pine Beetle Following Partial Cutting on the Shoshone National Forest, Wyoming*, Research Paper INT-396, available from the Intermountain Research Station.

Supplement to forest vegetation report published

In 1985 the Rocky Mountain Station published General Technical Report RM-123, a documentation of habitat types, community types, and plant communities in the Rocky Mountain and Intermountain regions.

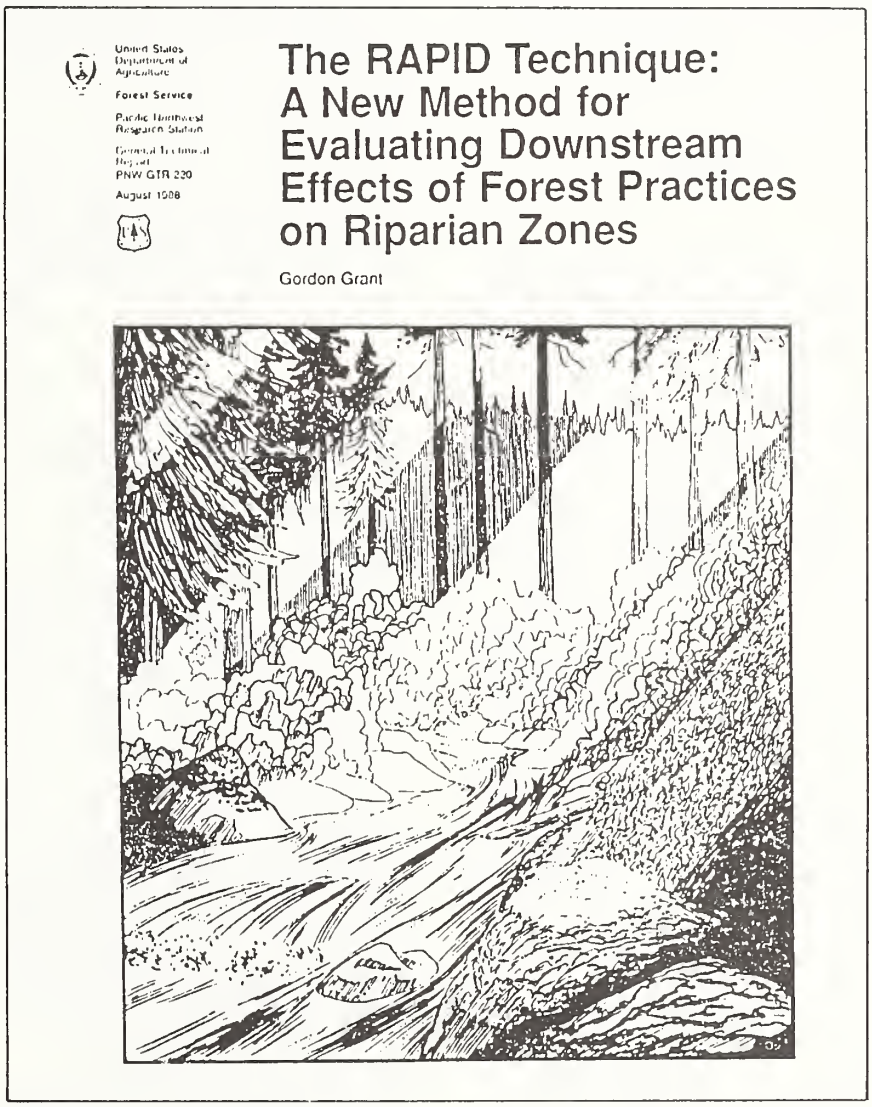
A supplement to that publication has now been issued that includes new data and data on phases omitted in the first report. *Forest Vegetation on National Forests in the Rocky Mountain and Intermountain Regions: Habitat Types and Community Types*, General Technical Report RM-162, covers name(s), general location, elevation, relative site, successional status, principal tree and undergrowth associates, and the authority. In addition, the habitat and community types in the series in which the naming species occurs, listed in the 1985 publication, are repeated for the readers convenience.

Copies are available from the Rocky Mountain Station.

A new method for evaluating downstream effects

Resource managers often assess and mitigate potential cumulative effects downstream of forest practices. Off-site changes in the volume or pattern of water and sediment movement through a basin from, for instance, harvesting upstream can cause channels and riparian communities to be modified. The downstream effects include a complex and interrelated set of hydrologic, geomorphic, and biologic processes that need measurement. The RAPID (riparian aerial photographic inventory of disturbance) technique has been developed for analyzing geomorphic processes in the densely forested west side of the Cascade Range (use in other areas should be considered experimental). This publication describes how to apply the RAPID technique and analyze results.

The technique offers a quick, inexpensive, yet quantitative approach for inventorying channel conditions by measuring patterns of canopy disturbance from aerial photos. Besides providing information about how upstream activities affect downstream channels, the RAPID technique is useful for identifying channel segments with histories of instability, evaluating basinwide effects of major storms, monitoring recovery of riparian areas following channel disturbances, and comparing the effectiveness of different management treatments in mitigating downstream effects.



Request *The RAPID Technique: A New Method for Evaluating Downstream Effects of Forest Practices on Riparian Zones*, General Technical Report PNW-220.

Aspen classification will aid resource managers

For those involved in the management of aspen-dominated woodlands, *Aspen Community Types of the Intermountain Region* provides a valuable tool. The vegetation classification in this publication is based on existing community structure and plant species composition. A community type approach is used because of the ill-defined successional status of communities within the overall aspen ecosystem. Community types are aggregations of similar plant communities based upon existing floristics regardless of successional status. As with habitat types, they are based on the premise that vegetation is an environmental integrator and thus reflects major environmental differences. Community types can be used as a basis for mapping, structuring information, and resource management planning.

The classification includes 56 community types that occur within eight tree-cover types. A diagnostic key using indicator species facilitates field identification of community types. The key is followed by narrative descriptions of the distribution, vegetal composition, successional status, and the forage and wood fiber productivity of each type. Appendix tables provide detailed comparisons of types.

The classification and descriptions are based on field data from more than 2,100 aspen stands scattered over southeastern Idaho, western Wyoming, Utah, and Nevada.

Request *Aspen Community Types of the Intermountain Region*, General Technical Report INT-250, available from the Intermountain Research Station.

Silvics of the whitebark pine

The picturesque whitebark pine, valued for wildlife habitat and watershed protection as well as esthetics, inhabits the high mountains of southwestern Canada and the western United States. In some areas, whitebark pine cone crops are diminishing because of successional replacement and insect and disease epidemics.

Published information on the species is sparse. *Silvics of the Whitebark Pine (Pinus albicaulis)*, General Technical Report INT-253, reviews the literature available in 1981 and is updated to include some recent ecological findings. The publication describes the whitebark pine's habitat, life history, growth and yield, mortality factors, special uses, and genetics. It may be obtained from the Intermountain Research Station.

Help for installing precipitation gages

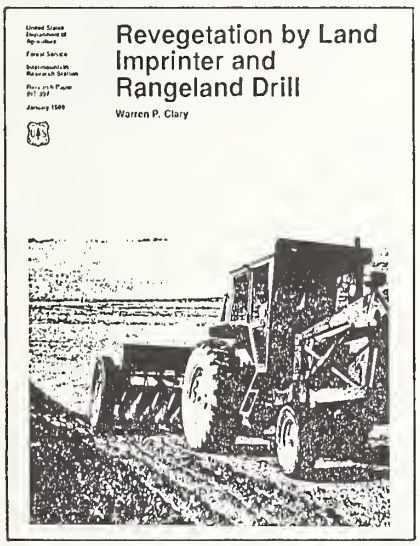
Obtaining reliable precipitation data in windswept regions remains a vexing problem. It is essential that wind velocity near the gage orifice be stilled sufficiently to allow particles to fall into the gage reservoir.

Rocky Mountain Station scientists have developed new procedures to ease the difficulties in installing precipitation gages and modified Alter windshields, and improve their operating performance, particularly those in areas where blowing snow and cold temperatures are common.

Details of these procedures are available in *Improved Procedures for Installing and Operating Precipitation Gages and Alter Shields on Windswept Lands*, Research Note RM-489. The Rocky Mountain Station has copies.

Rangeland revegetation methods compared

Research Paper INT-397, *Revegetation by Land Imprinter and Rangeland Drill*, compares the effectiveness of rangeland imprinting with that of a standard rangeland seeding technique, rangeland drilling.



Rangeland imprinting is a technique by which simple machines imprint land surfaces with geometric patterns. Developers of the technique suggested that its advantages over conventional tillage implements include ability to increase depression water storage without inverting the soil surface, to increase effective surface mulch by concentrating all aboveground plant materials at the soil surface, and to impress the soil surface with geometric patterns for better control of infiltration, runoff, and erosion.

The techniques were compared for revegetation of a wildfire burn in the Wyoming big sagebrush type. Total seeded plant densities and cover were significantly higher with the imprinting treatment. The paper also discusses results in terms of production and soil response.

Contact the Intermountain Research Station to obtain a copy of this publication.

Discussing economic valuation

As demands on publicly administered natural resources grow, the need to know more about the beneficial and detrimental consequences of alternative resource allocations also increases. Monetary valuation of the gains and losses is an important part of this needed information. These monetary values include marginal prices for products exchanged in reasonably competitive markets and for amenity goods and services. There is also a need for nonmarginal valuation of market and nonmarket natural resource products.

Last year over 40 scientists, administrators, educators, and others met in Estes Park, Colorado to discuss economic values and describe the beneficial consequences of amenity goods and services. Their presentations have been recorded in a publication designed to promote better application of the concepts and methods of economic valuation in the broad sense of human welfare, rather than the more narrow perspective of monetary transactions.

Topics covered include: the amenity valuation problem, approaches to valuation, concerns about economic measures, methods of monetary valuation, and methodological issues in economic valuation. The book, *Amenity Resource Valuation: Integrating Economics with Other Disciplines*, is available for $29.45, including postage, from Venture Publishing Inc., 1640 Oxford Circle, State College, Pennsylvania 16803.

Program calculates fish population statistics

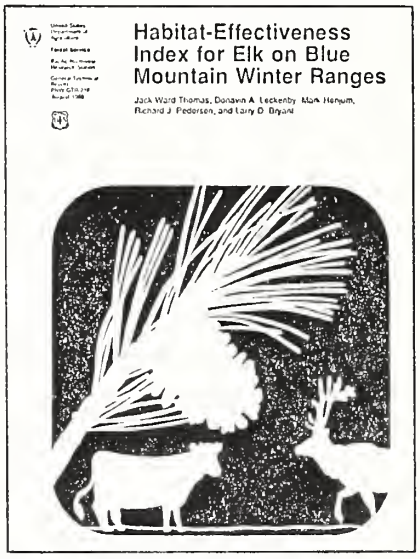
A General Technical Report recently issued by the Intermountain Research Station guides users of MicroFish 3.0, a minicomputer software system designed for calculating fisheries population statistics from electrofishing data. The system consists of programs written in the BASIC language and is functional on all IBM personal computers and compatibles using DOS 2.0 or higher.

System output includes maximum-likelihood population estimates, total catches, capture probabilities, removal patterns, lengths, weights, condition factors, and biomass. Output options enable the user to create tables on database files, which can be used as input for statistical, spreadsheet, or graphics packages. Sample size programs display two- and three-dimensional color graphs for predicting the number of electrofishing passes needed to achieve a desired precision level in the population estimate.

Request *Microcomputer Software System for Generating Fish Population Statistics from Electrofishing Data—User's Guide for MicroFish 3.0*, General Technical Report INT-254.

Modeling of elk-habitat effectiveness

Resource managers in the intermountain West often consider elk habitat in forest planning and management. The process of habitat evaluation in conjunction with evaluating other resources is important to how well wildlife biologists can manage for elk and elk hunting. General Technical Report PNW-225 examines the need for and the evaluation of elk-habitat evaluation models. The report also discusses the evolution of a state-of-the-art example of a proposed model. The model, developed for the Blue Mountain Winter Ranges, is presented in detail in



General Technical Report PNW-218. The model incorporates distribution of elk-habitat use related to distance from cover/forage edges, distance from roads, cover quality, and forage quantity and quality.

Request *Integrated Management of Timber-Elk-Cattle: Interior Forests of Western North America*, General Technical Report PNW-225, and *Habitat-Effectiveness Index for Elk on Blue Mountain Winter Ranges*, General Technical Report PNW-218.

To order any of the publications listed in this issue of *Forestry Research West*, use the order cards below. All cards require postage. Please remember to use your Zip Code on the return address.

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3. *Integrated Management of Timber-elk-cattle: Interior Forests of Western North America*, General Technical Report PNW-225.
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3. *Fidelity to Territory and Mate in Flammulated Owls*, a reprint.
4. *Brood Division and Postnesting Behavior of Flammulated Owls*, a reprint.
5. *Improved Procedures for Installing and Operating Precipitation Gages and Alter Shields on Windswept Lands*, Research Note RM-489.
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2. *Lodgepole Pine Vigor, Regeneration, and Infestation by Mountain Pine Beetle Following Partial Cutting on the Shoshone National Forest, Wyoming*, Research Paper INT-396.
3. *Revegetation by Land Imprinter and Rangeland Drill*, Research Paper INT-397.
4. *Aspen Community Types of the Intermountain Region*, General Technical Report INT-250.
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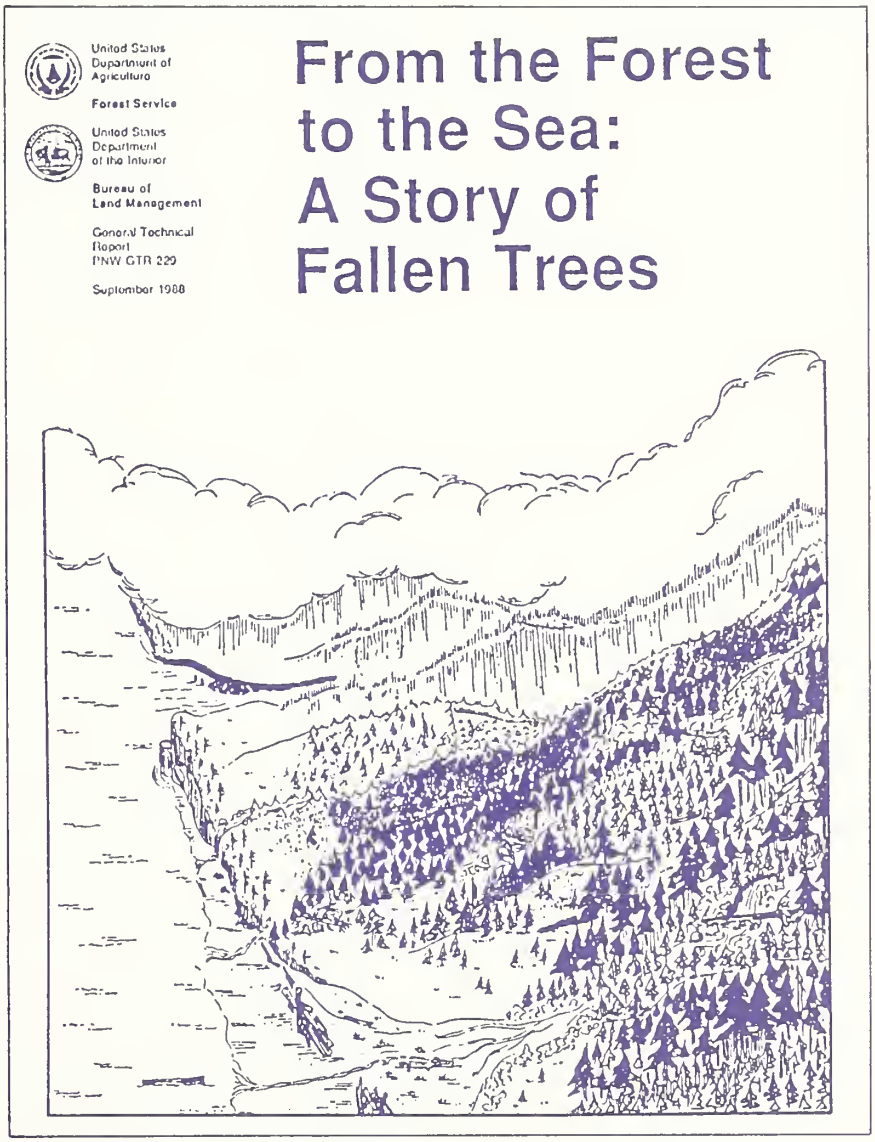
A story of fallen trees

Large fallen trees in different stages of decay contribute much-needed diversity in the ecological processes of forests, rivers, streams, estuaries, coastal beaches, and oceans in the Pacific Northwest. Intensive utilization and management can deprive these areas of habitats created by large fallen trees. *From the Forest to the Sea: A Story of Fallen Trees* documents that large dead trees are not a wasted resource but function as an important part of a terrestrial or water system. In this research synthesis, the fourteen authors provide information for managers to use as they make decisions impacting habitat diversity and ecological processes.

A sample of the information in the publication is distribution of coarse woody debris by decay class in young, mature, and old-growth Douglas-fir stands; some uses of snags by selected wildlife species; role of woody debris in storing sediment and creating pools in streams; and history of wood in Northwest estuaries and coastal beaches. In the last chapter, intensive and diversified forest management are compared as opposing ends of a continuum of philosophies and techniques available to the forest manager. Most of the information is specific to the Coast Range of Oregon but also applies generally to western Oregon, western Washington, western British Columbia, and southeastern Alaska.



Request *From the Forest to the Sea: A Story of Fallen Trees*, General Technical Report PNW-229.

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